Soilborne plant pathogen dispersal and assessment: Building a remote sensing-based global surveillance system for plant disease

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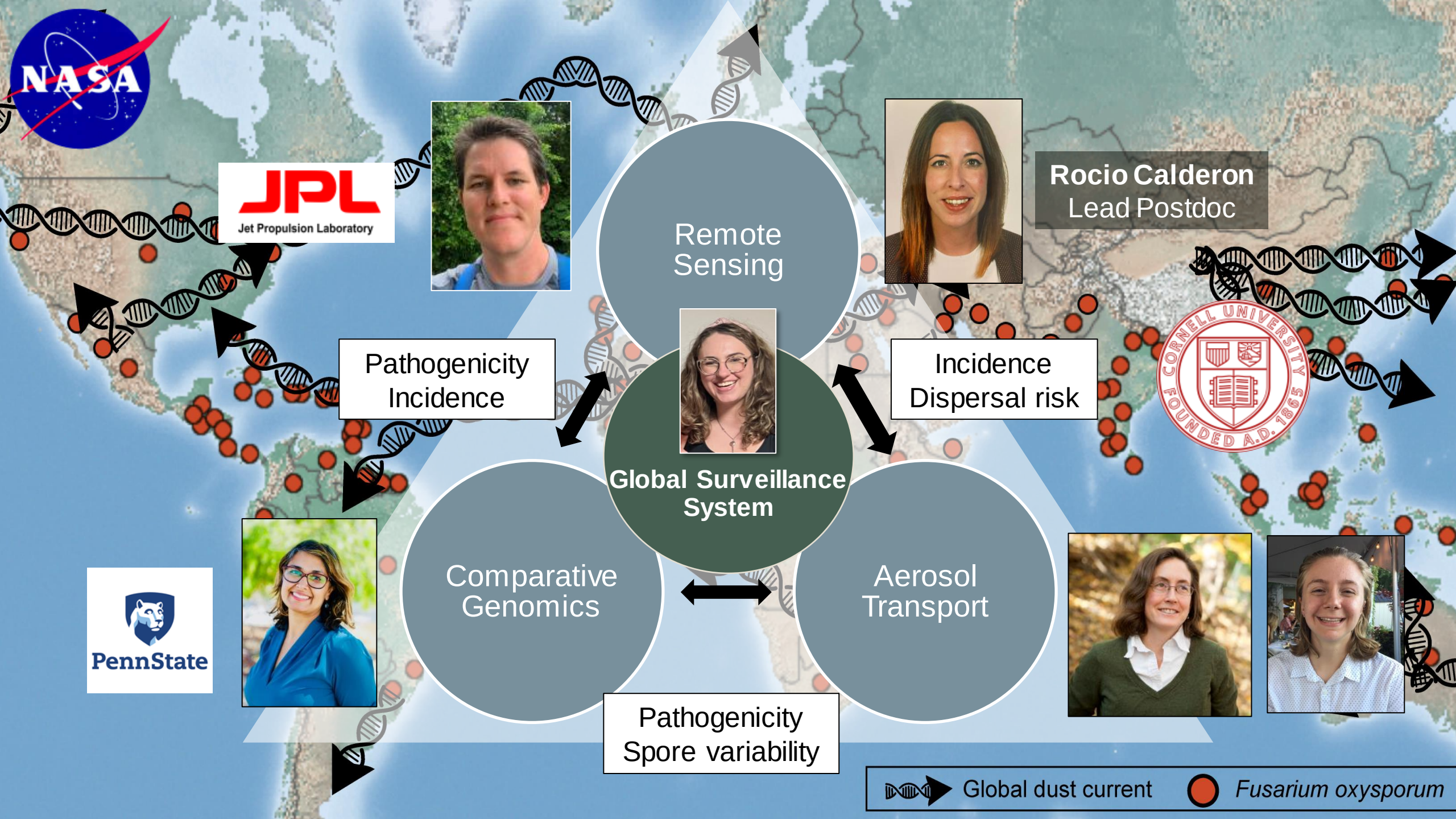
Fusarium oxysporum (Fo)

- Causes Fusarium Wilt (FW) in 100+ hosts
- Survives in soil for 20+ years
- Annual yield losses ~10-60%
- Range expansion expected with climate change (Shabani et al. 2014)
- **Preserving existing agroecosystems is critical to preserving natural ecosystems and global biodiversity**


NASA
JPL
Jet Propulsion Laboratory
Rocio Calderon
Lead Postdoc
Remote Sensing
Pathogenicity
Incidence
Incidence
Dispersal risk
Global Surveillance System
Comparative Genomics
Aerosol Transport
Pathogenicity
Spore variability
PennState
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Global dust current
Fusarium oxysporum

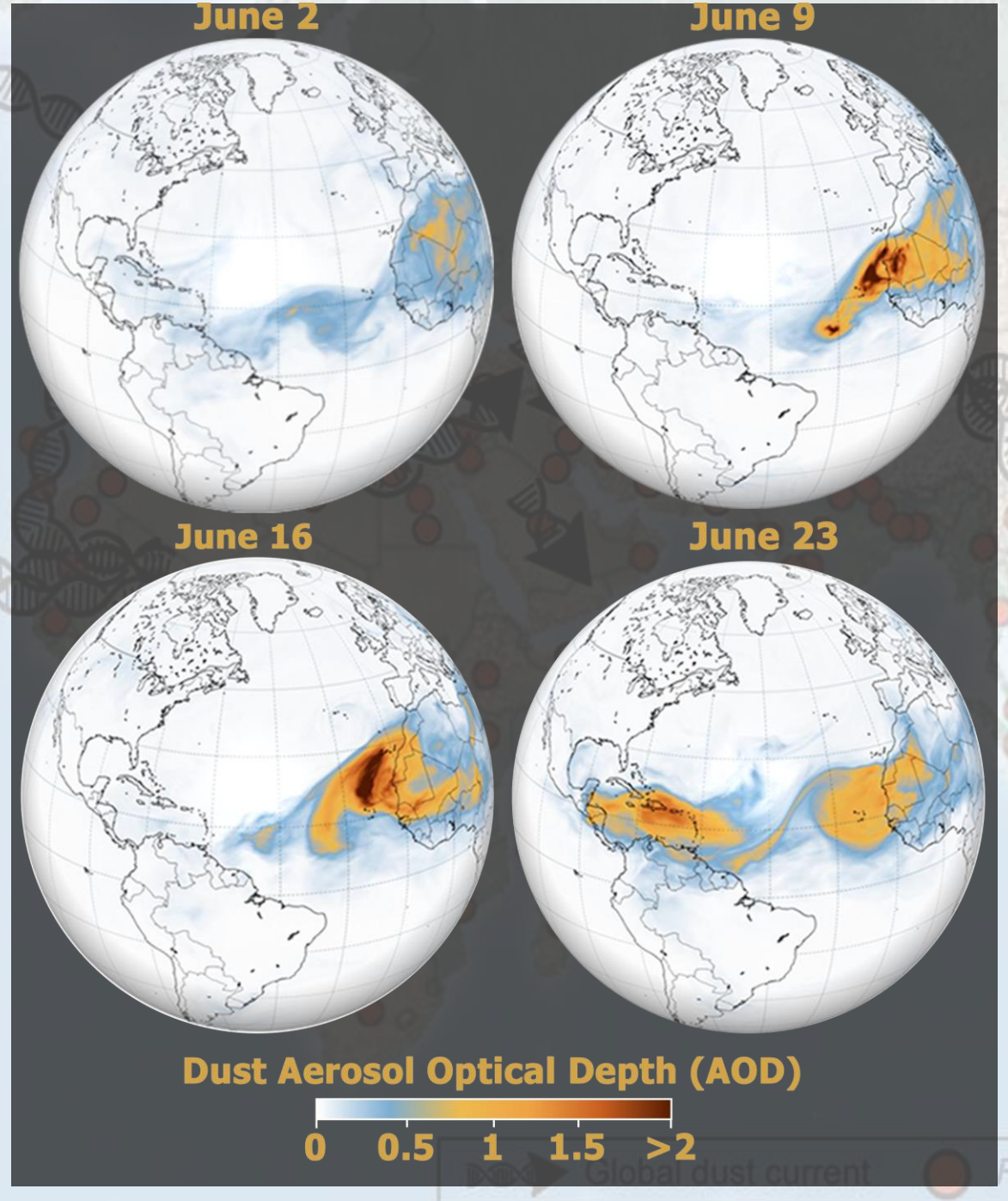
Aerosol Transport

Build a model of long-distance atmospheric *Fo* spore transport and assess the likelihood of transatlantic transport of viable spores

In order to ask "**Can viable Fo spores be transported across the Atlantic?**"

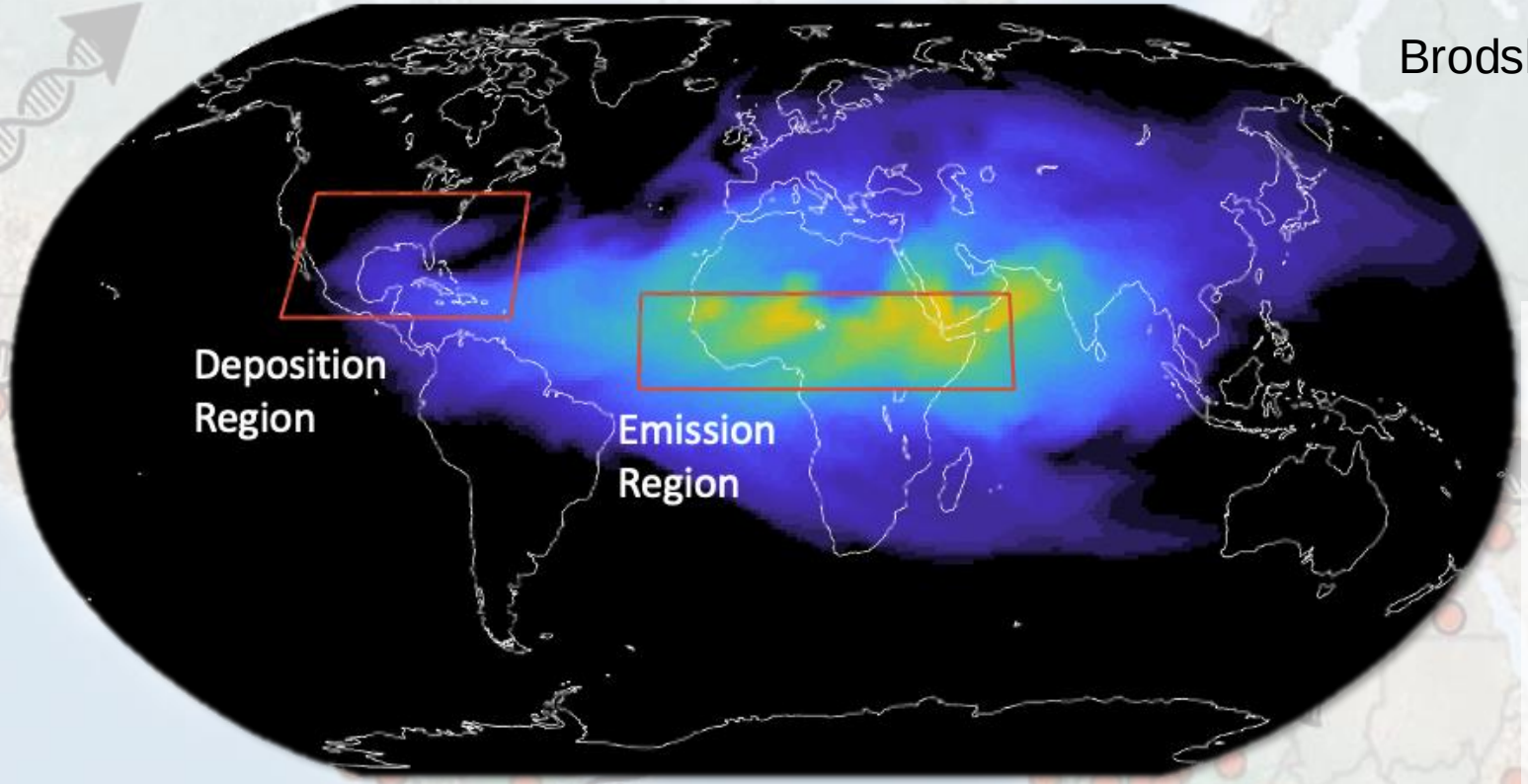
We first had to….

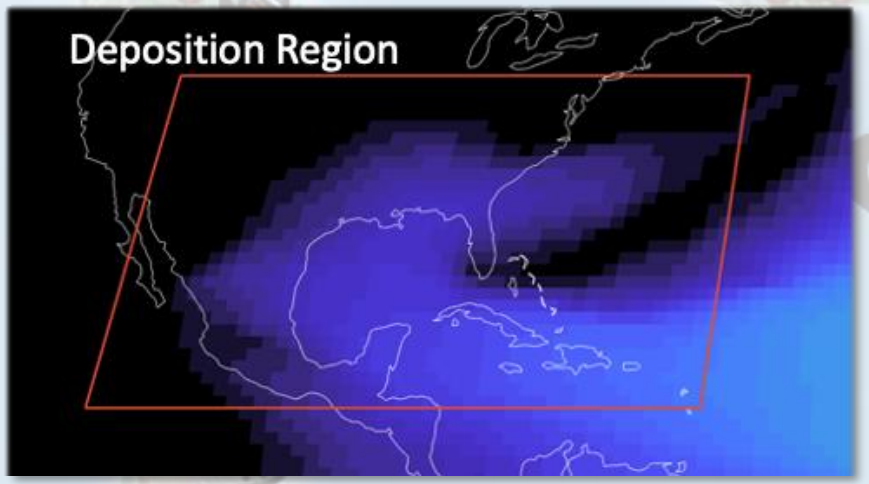
1) …accurately simulate the "Godzilla" dust event of Summer 2020
2) …adapt the CESM-CAM6-MIMI to include **agricultural dust**
3) …adapt the step 2 model to include **spore transport** with uniform concentration and fixed properties (e.g. size, weight) and an exponential decay function to kill off 99% of spores in 3 days

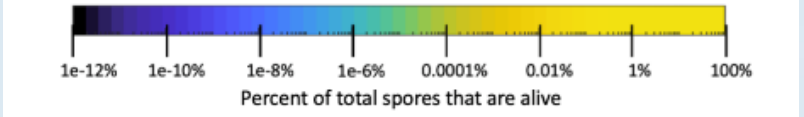


Brodsky et al. *in review*

Brodsky et al. *in review*





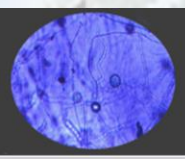


Almost all spores lose viability before reaching Americas…. **but not all!**

- Our model indicates that **~4 million live spores** could have been deposited in North America in June 2020
- Theoretically, if there is substantial fungal infestation in North Africa, a big dust event like Godzilla could carry millions of live spores to the Americas.
- Collaborating to assess dust samples for *Fo* fsp presence

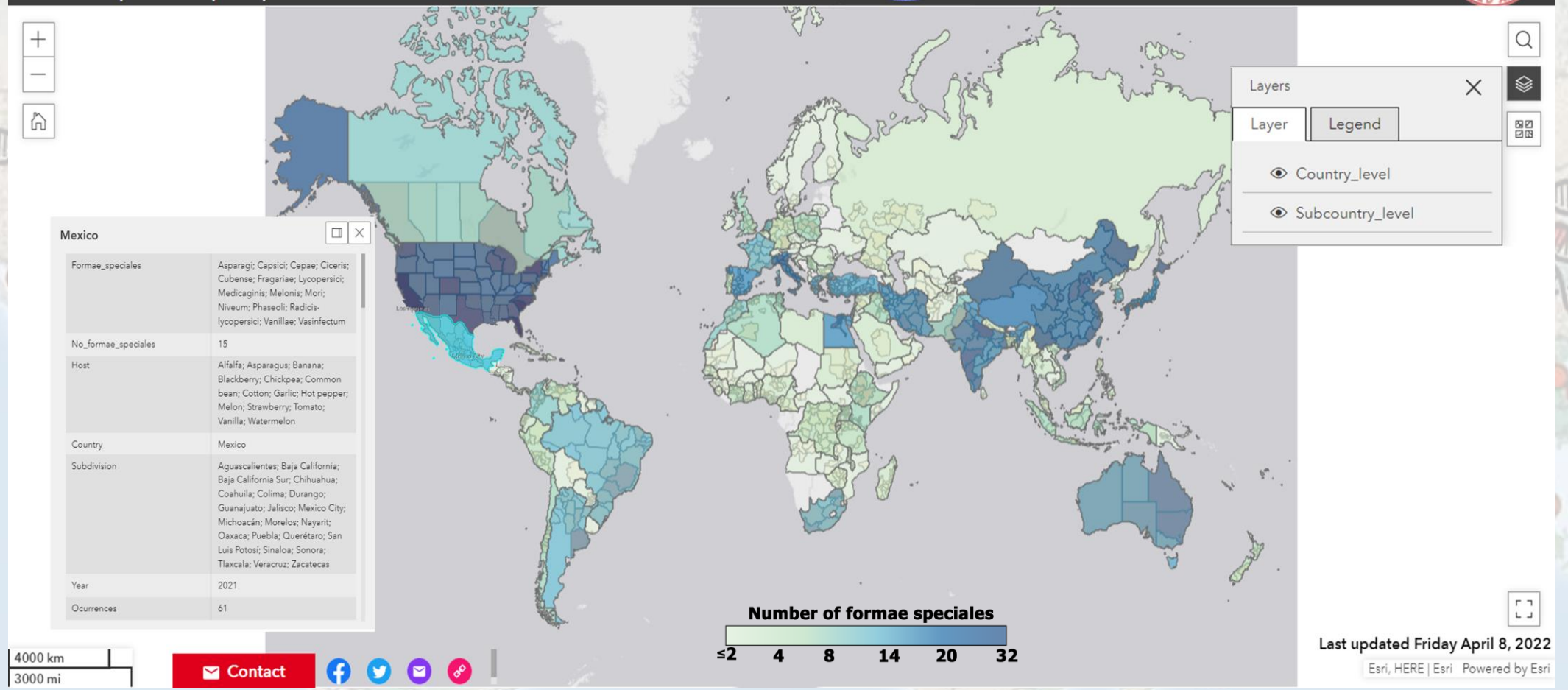
Global dust current *Fusarium oxysporum*

Fusarium oxysporum ff. spp. diversity and distribution



Fusarium oxysporum ff. spp.

This web map was developed as part of NASA Grant #80NSSC20K1533



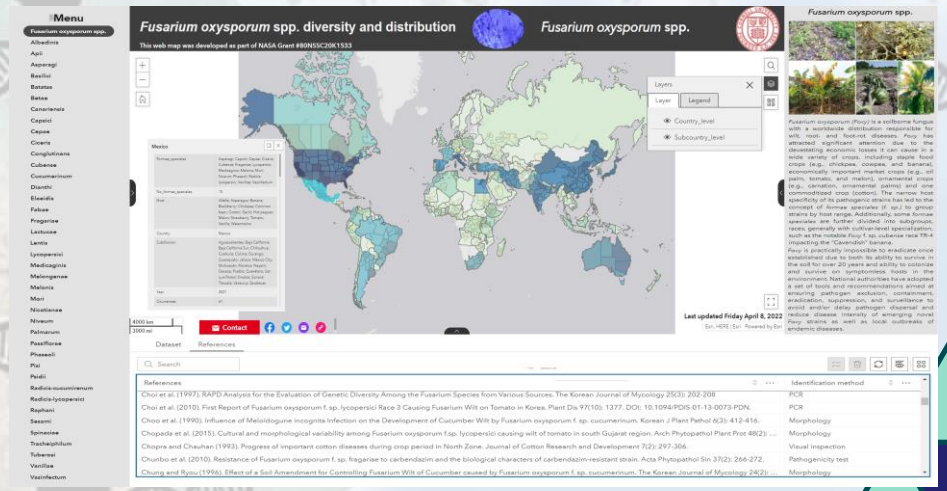
Remote Sensing

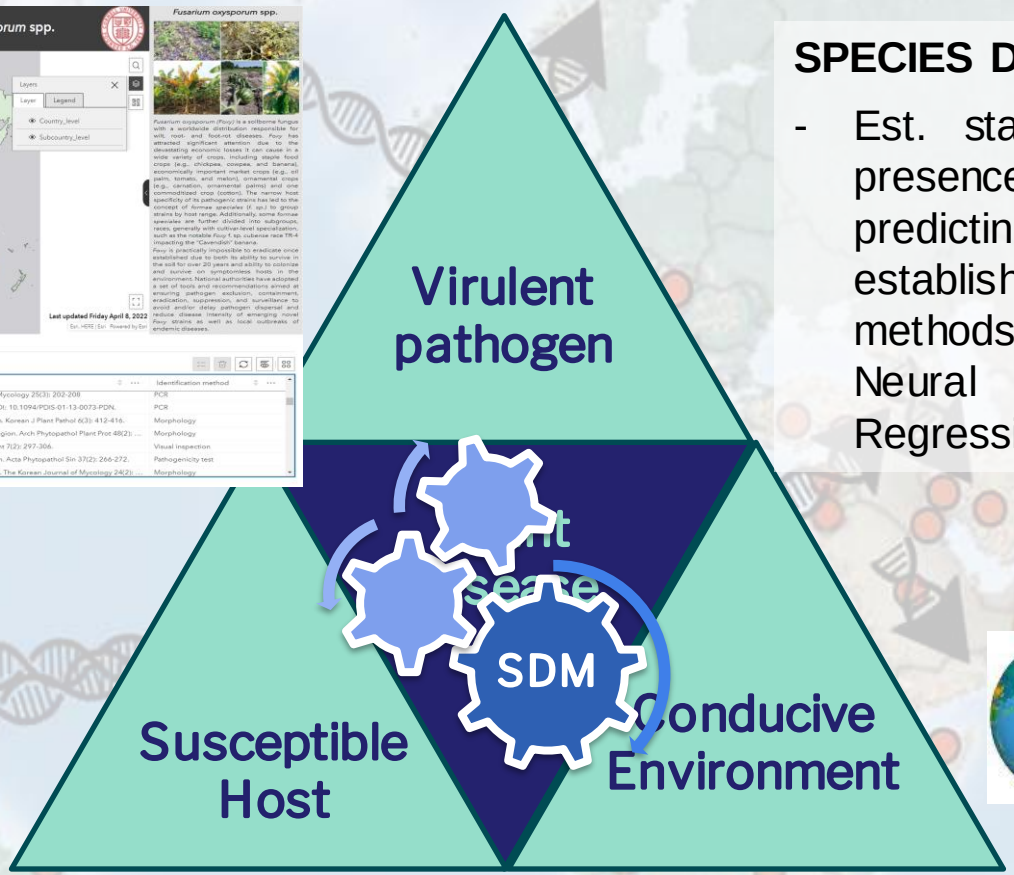
Build susceptibility assessment for current *Fo* risk in agricultural zones form remote sensing measurements

Calderón, R., Eller, J., Brodsky, H., Miles A., Crandall, S., Mahowald, N., Pavlick, R., and Gold, K. (in press). An interactive, online web map resource of global *Fusarium oxysporum* ff. spp. diversity and distribution. *Plant Disease.*

SCAN ME to visit the online web map

Global dust current

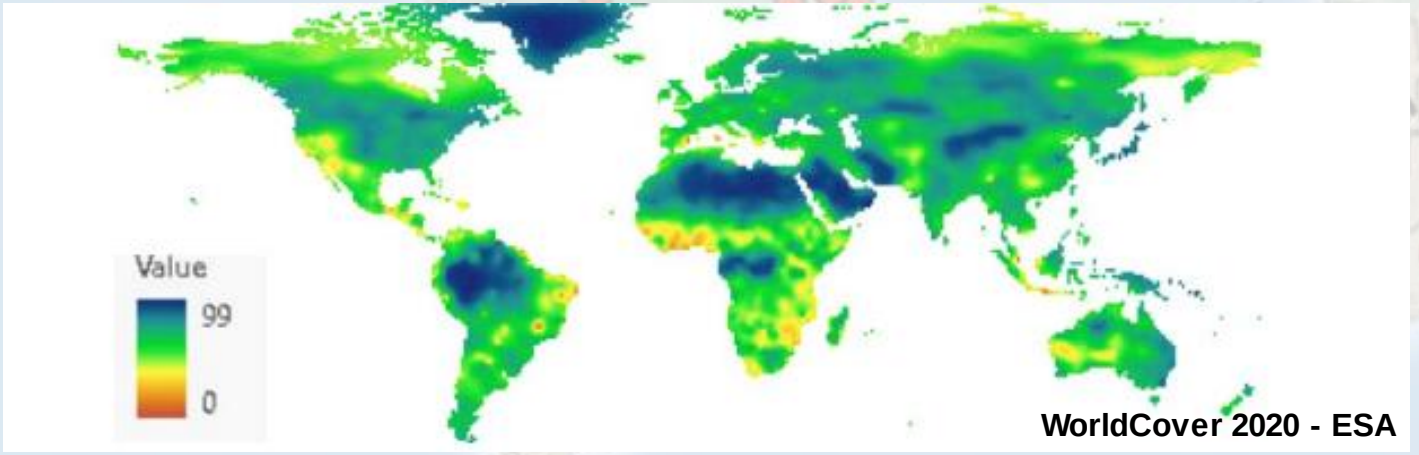




SPECIES DISTRIBUTION MODELS (SDMc)

- Est. statistical reletionships between species presence and agro-environmental variables, thus predicting the geographical suitability for its establishment. Based on machine-learning methods: MaxEnt (Maximum Entropy), Artificial Neural Networks, Random Forests, Boosted Regression Trees and Support Vector Machines.

CHELSA



Independent variable

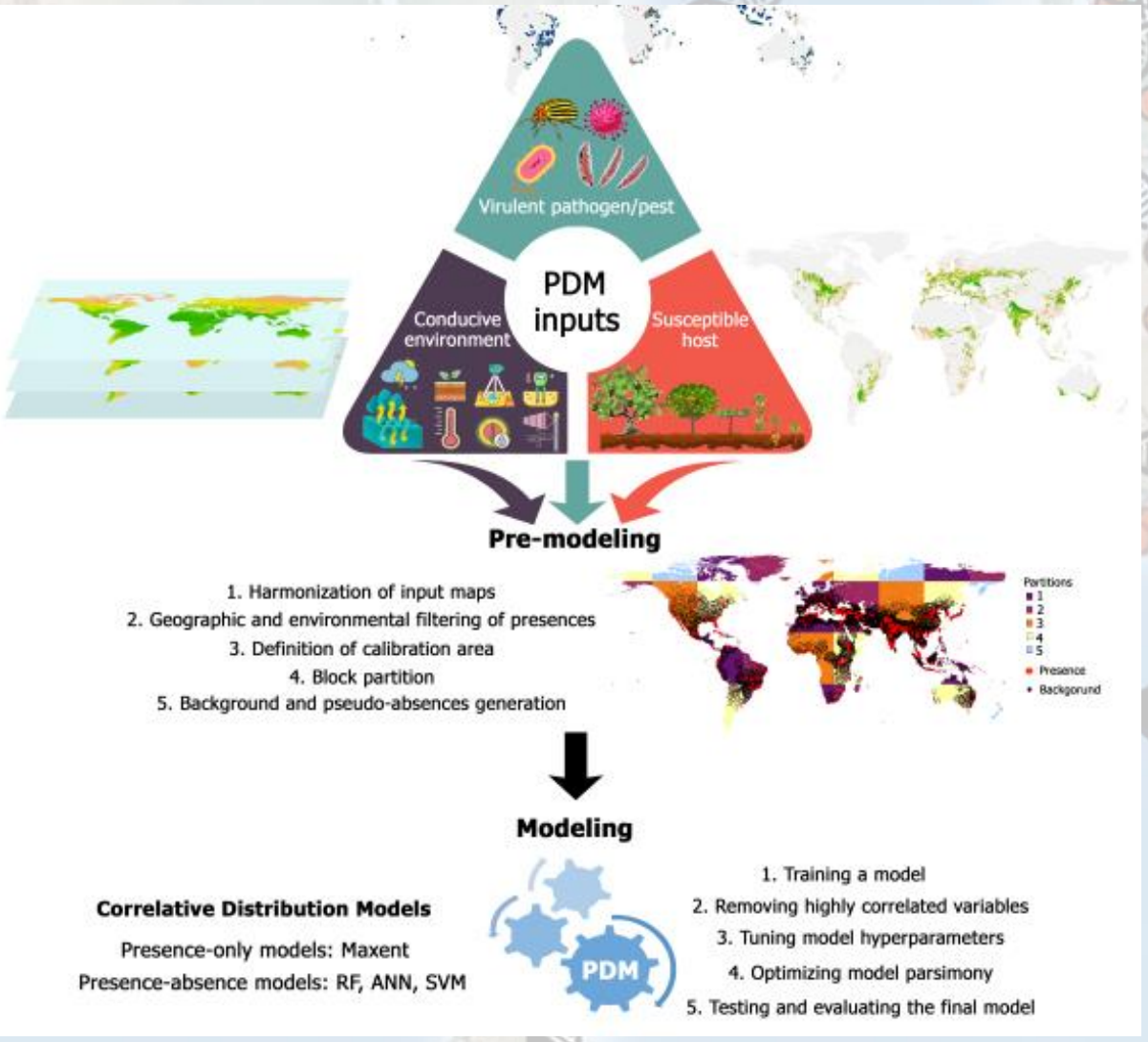
Climate, land cover, soil attributions, etc

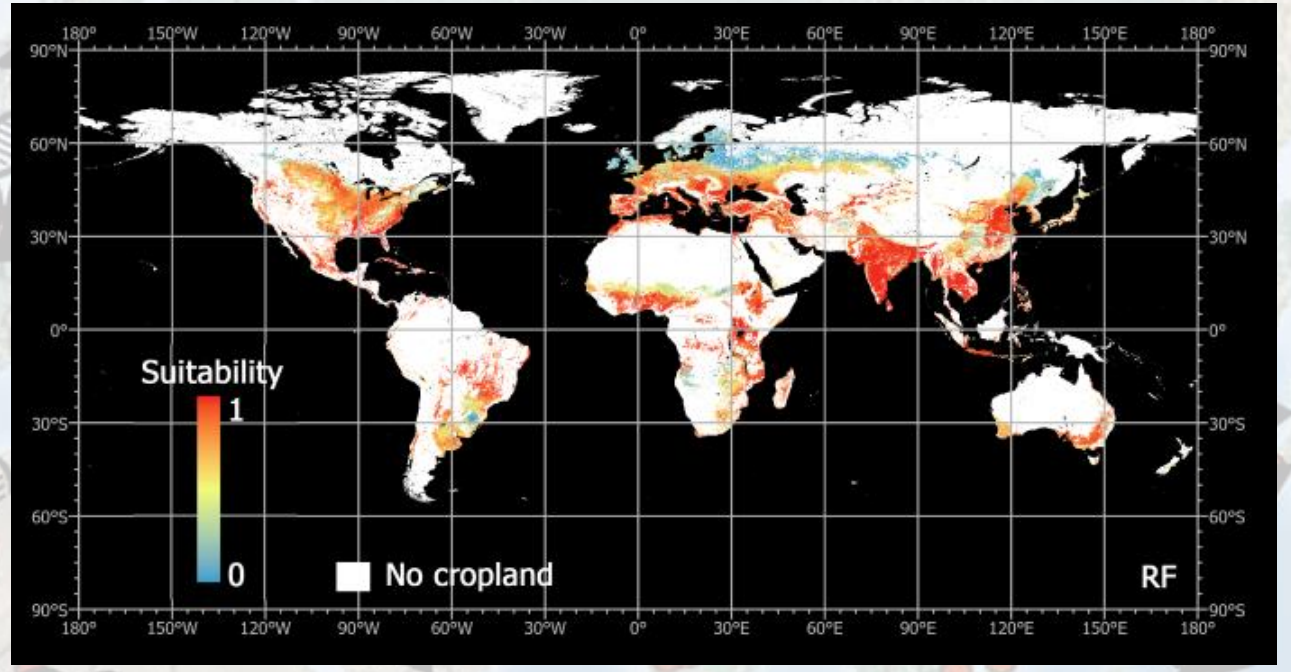
Global dust current

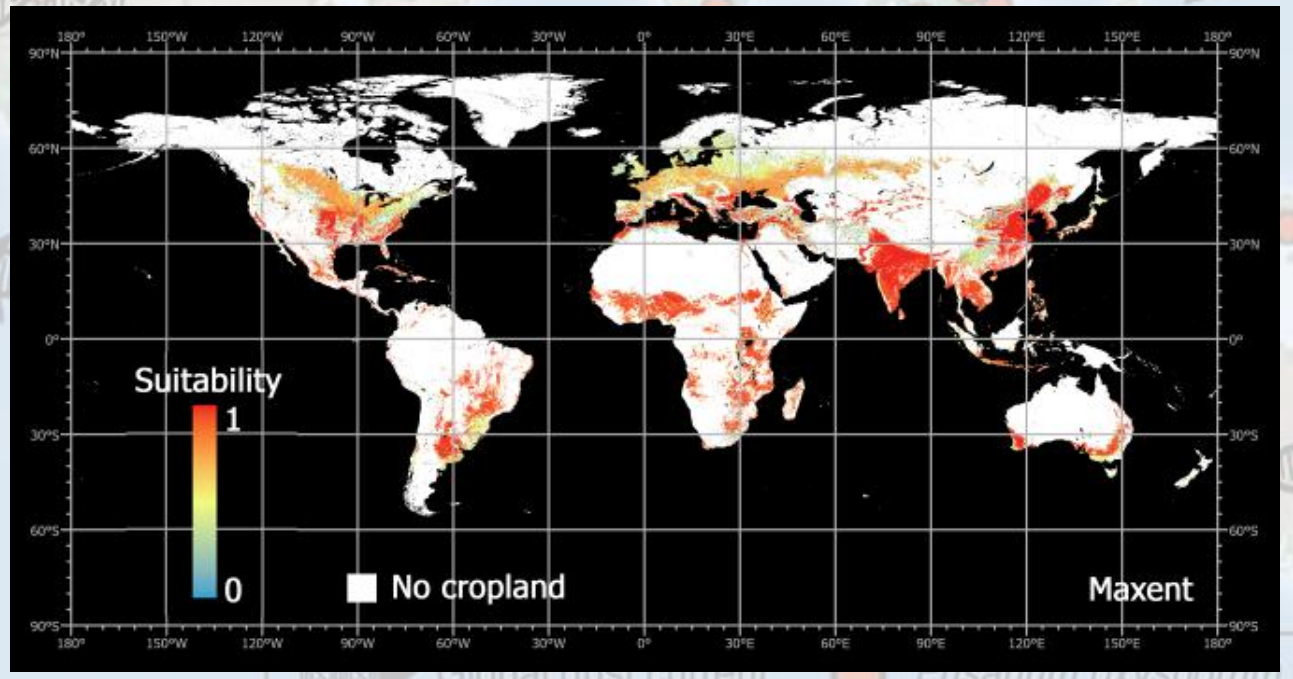
Fusarium oxysporum

Pathosystem Distribution Modeling

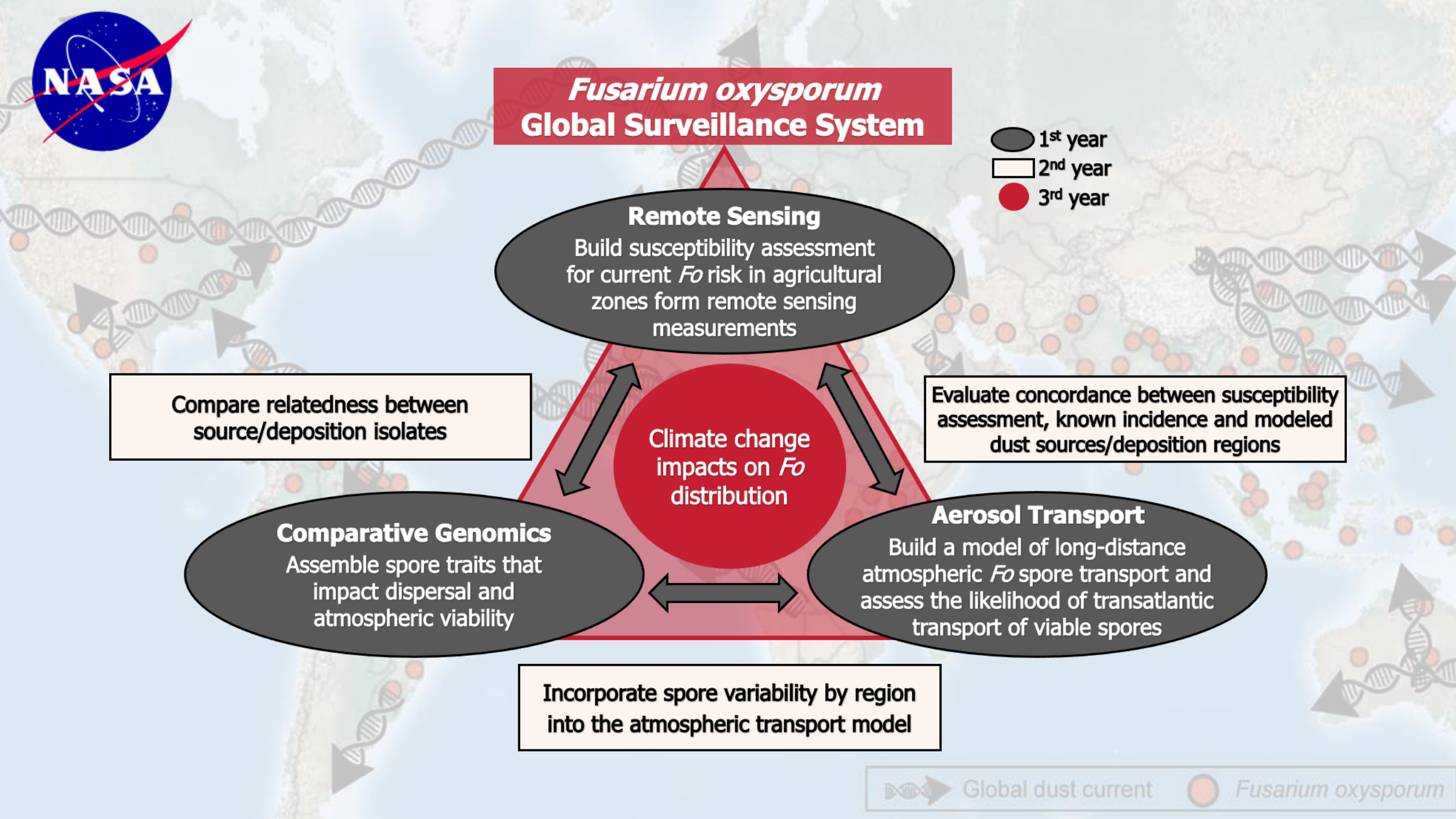
Based on Species Distribution Modeling







Calderon et al in prep


Fusarium oxysporum
Global Surveillance System
1st year
2nd year
3rd year
Remote Sensing
Build susceptibility assessment for current Fo risk in agricultural zones form remote sensing measurements
Compare relatedness between source/deposition isolates
Evaluate concordance between susceptibility assessment, known incidence and modeled dust sources/deposition regions
Climate change impacts on Fo distribution
Comparative Genomics
Assemble spore traits that impact dispersal and atmospheric viability
Aerosol Transport
Build a model of long-distance atmospheric Fo spore transport and assess the likelihood of transatlantic transport of viable spores
Incorporate spore variability by region into the atmospheric transport model
Global dust current
Fusarium oxysporum

Thanks!

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